Graduate School of Computational Engineering

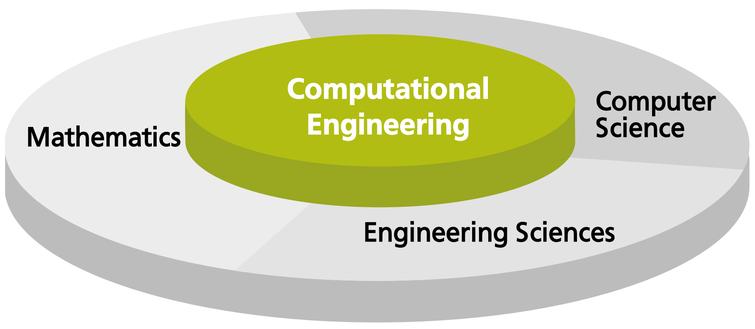
TECHNISCHE UNIVERSITÄT DARMSTADT

FORUM INTERDISZIPLINÄRE FORSCHUNG

Interdisciplinary Research Excellence

Interdisciplinarity

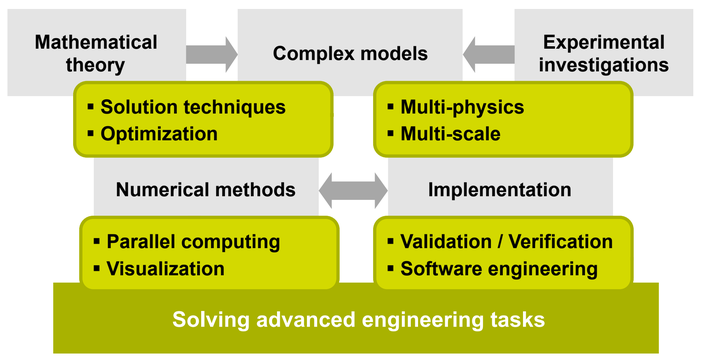
Topics and Research Activities of the Graduate School of Computational Engineering



Research Activities

- Highly innovative research projects
- Innovative research program based on close interaction of methods and applications
- Research Focus on Multiphase Flows, OpenFOAM Conference in Darmstadt
- Demonstrative Applications: Wind energy plant, Fluid-Structure-Interaction
- Communication systems and Optimization
- Discontinuous Galerkin Method in Electromagnetics and Flow Dynamics
- Best paper awards and other prizes of affiliated researchers
- Joint conference series in CE together with RWTH Aachen, TU München and University of Stuttgart

Requirements



Mathematics

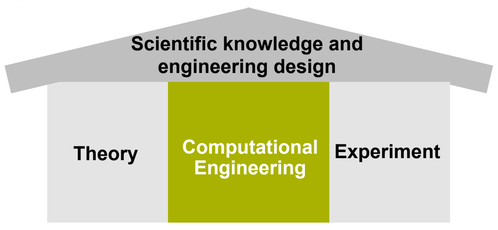
- Mathematical Modeling and Analysis
- Numerics of PDEs
- Nonlinear Optimization and Optimal Control
- Discrete Optimization
- Probability Theory and Stochastic Analysis
- Numerical Analysis and Scientific Computing

Computer Science

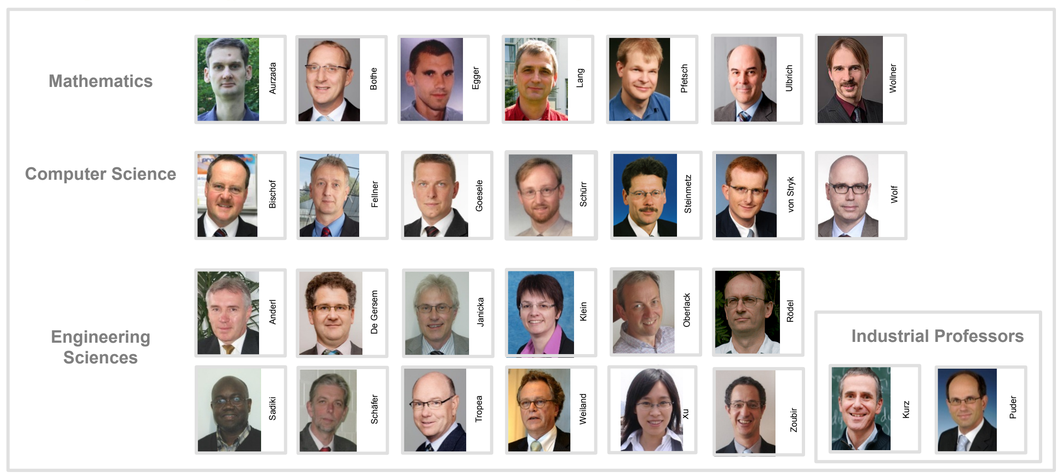
- High Performance Computing
- Graphical Interactive Systems
- Software Engineering
- Multimedia Communications
- Simulation, Systems Optimization, Robotics
- Simulation of Multibody Systems and Deformable Bodies

Engineering Sciences

- Computer Integrated Design
- System Reliability and Machine Acoustics
- Energy and Powerplant Technology
- Communications Engineering
- Fluid Dynamics, Aerodynamics
- Ceramics
- Numerical Methods
- Theory of Electromagnetic Fields
- Mechanics of Functional Materials
- Signal Processing
- Adaptive Systems for Processing of Speech and Audio Signals
- Numerical Methods in Electromagnetics, Model Order Reduction



Principle Investigators and Research Group Leaders of the GSC CE



Scientific Highlights

Optimal Flow Control based on POD and MPC and an Application to the Cancellation of Tollmien-Schlichting waves

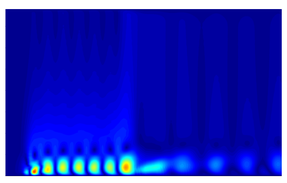
GSC Student: Jane Ghiglieri; Supervisor: Ulbrich (Nonlinear Optimization and Optimal Control), Co-Supervisor: Tropea (Fluid Mechanics and Aerodynamics)

Description:

- Cancellation of Tollmien-Schlichting waves in the boundary layer of a flat plate
- Control of the flow with a body force induced by a plasma actuator
- Close cooperation with experiments and numerical investigations

Methods/Results:

- Proper Orthogonal Decomposition for the low-order description of the flow
- Special snapshot ensemble applicable to optimal control problems
- A-priori error estimator
- Design of a feedback controller with Model Predictive Control
- Numerical experiments

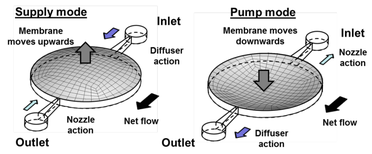


Numerical Modeling of a Valveless Micro-pump in Application of Pumping Complex Non-Newtonian fluids

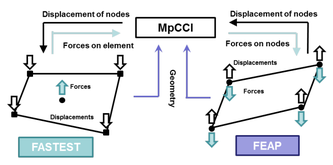
GSC Student: Xingyuan Chen; Supervisor: Dieter Bothe (Mathematical Modeling and Analysis); Co-Supervisor: Michael Schäfer (Numerical Methods in Mechanical Engineering)

Description

- Application: Valveless micropumps for industry and medical applications
- Main challenge: Stable simulation of complex non-Newtonian fluid flows and their interactions with elastic solids
- Aim: Development of an efficient numerical framework for analysis and design of micropumps.



Pumping principle of a valveless micropump



Schematic of coupling and data flow between solvers

Methods/ Results

- Finite-volume code FASTEST for fluid Finite-element code FEAP for solid Implicit partitioned coupling via MpCCI
- Advanced stable and high accurate approaches for simulation of viscoelastic non-Newtonian fluid flows
- Simulations for pumping Newtonian fluids are compared with the experiments
- The pumping efficiency for transporting viscoelastic fluids is studied via simulations

Methods for Higher Order Numerical Simulations of Complex Inviscid Fluids with Immersed Boundaries

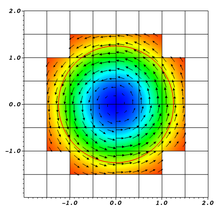
GSC Student: Björn Müller; Supervisor: M. Oberlack (Fluid Dynamics), Co-Supervisor: S. Schnepp (Computational Electromagnetics Group)

Description:

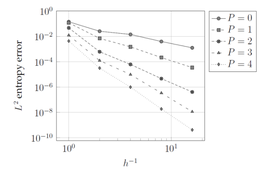
- Application: Compressible single- and multiphase flows with immersed interfaces
- Challenge: Efficient numerical integration over the complex and strongly curved zero level set with high accuracy

Methods/Results:

- Discontinuous Galerkin Method
- Non-smooth enrichment of the basis functions
- Improved numerical integration by mean of hierarchical moment-fitting

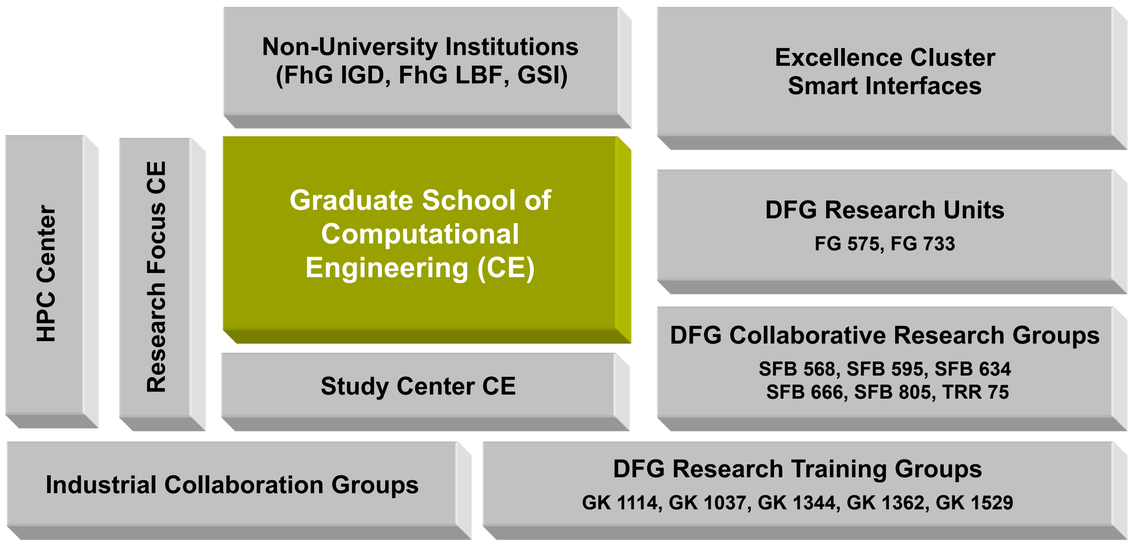


Pressure distribution of an isentopic vortex in a circular domain defined by a zero level set (red)



Corresponding h-convergence study revealing an experimental order of convergence of p+1

Research Environment



International and industrial Cooperations

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